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Observations on the larval morphology of the Antlion *Myrmeleon bore* (Tjeder, 1941) (Neuroptera Myrmeleontidae) and its life cycle in the Po Valley (northern Italy)

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Myrmeleon bore (Tjeder), an Eurasian antlion, has hitherto been recorded only in few localities of northern Italy, the southernmost part of its range. The author carried out observations in the Pavia province (western Po Valley) and rearings of this species, in order to obtain data concerning larval morphology, ecology and ethology, as well as to study its life cycle. Field observations and laboratory rearings indicate that the life cycle of *M. bore* in northern Italy may be completed in one year. The morphological characteristics of its three larval stages are noted and illustrated by SEM micrographs, discriminating them from those of the very similar and syntopic *M. inconspicuus* Rambur.

Key words – larval taxonomy, SEM, geographic distribution, voltinism, myrmeleontids.

Introduction

Myrmeleon bore (Tjeder, 1941) (Neuroptera: Myrmeleontidae), an Eurasian antlion, occurs in Europe mostly in the central and northern regions (Ohm, 1965; Aspöck *et al*., 1980, 2001; Letardi, 1998; Röhricht, 1998); in Italy it has hitherto been recorded very rarely and only in the North (Aspöck & Aspöck, 1969; Nicoli Aldini, 1983; [Bernardi] Iori *et al*., 1995; Hellrigl & Hölzel, 1996). Field studies in the Lomellina area (Province of Pavia, Lombardy) and laboratory rearings have been carried out by the author, since the seventies, for obtaining data on the ecology, behaviour and life cycle of this species. Observations have also been conducted using a scanning electron microscope in order to depict the morphological characteristics of its larval stages and differences between them and the corresponding stages of the very similar and syntopic *M. inconspicuus* Rambur, 1842. The mature larva of the latter was described masterfully by Principi (1943); taxonomical characteristics of the larva of *M. bore* were summarily presented by Friheden (1973), other illustrations are to be found in Dobosz (1993) and Ábrahám (1995).

Materials and methods

After the first findings of *M. bore* larvae in the Lomellina area, the research was widened to other stations in this region; moreover, some collections were examined to obtain further data on the presence and distribution of this antlion species in Italy.

The observations and samplings of larvae of *M. bore* and other antlions digging pits, were made in the Lomellina area during a period of nearly thirty years (1977 to 2005), in June-July and September-October. Laboratory rearings were conducted in Bologna, in an unconditioned environment.

Larval specimens were examined alive and shortly before death, as well as specimens preserved in ethanol 70-75%, dry specimens and cast skins from 1st and 2nd instar larvae, in order to study larval morphology. SEM micrographs were carried out in the Electron Mi-

croscope Laboratory of the Faculty of Agriculture, Università Cattolica, Piacenza, employing both non-metallized and metallized dry material, by means of a SEM Philips XL30 ESEM. Measurements of total larval length were conducted on live specimens; measurements of larval head (Fig. 3B) were conducted on specimens preserved in ethanol 70-75% (12 specimens for each stage of each species were examined), by means of a Leica Wild M 10 stereoscope, using an ocular micrometer. Other observations on larval morphology were carried out on prepared parts or appendages, previously clarified in KOH and mounted on slides in Faure's fluid. The "digging-setae" layout patterns of the 9th sternite and their relative frequencies were observed by examining a total of 263 *M. bore* larvae (L1: 69, L2: 150, L3: 44) (Tab. II) and 392 *M. inconspicuus* larvae (L1: 27, L2: 256, L3: 109). Detailed data on the latter species will be published in a future paper.

Results

Distributional data for *M. bore*

M. bore larvae were found in various localities of the southeastern Lomellina area (Pavia), both along river beds, and in some zones of the inland plain: a) Mezzana Rabattone, Po river; b) Pieve Albignola: Cascinotto Mensa, Po river; c) Pieve Albignola, Terdoppio stream; d) Pieve Albignola to Scaldasole: sandy banks and oak-wood borders near Cascina Rossa (now demolished) and Cascina Paralupo; e) Scaldasole, locality "I Dossi": borders of a small oak-wood; f) Alagna. In the collections of the Istituto di Entomologia, Università Cattolica, Piacenza, 3 adults of this species are preserved, labelled as follows: Cremona, Pizzighettone, farm "La Tencara", 19.VII.1970, light trap (1 female); Piacenza, 28.VII.1989 (1 male); Piacenza, Po river, VI.1991 (1 male). *M. bore* therefore, as published up to now, occurs in three Italian regions: Alto Adige (Aspöck & Aspöck, 1969; Hellrigl & Hölzel, 1996), Lombardy and Emilia (Nicoli Aldini, 1983, and present data) (Fig. 1).

Larval morphology of *M. bore*

1st instar larva (L 1)

Colouring – Basic colouring whitish straw, dorsally tending towards beige, with several brown or dark brown spots and blotches dorsally and ventrally (Fig. 2, Fig. 3A) (newhatched larva with only the cephalic and some, more or less evident, thoracic and abdominal spots). Head capsule dorsally almost entirely dark brown, due to the presence of large and confluent spots in the fronto-clypeal and epicranial areas (the epicranial spots extending to the sides); ocular tubercles black; head capsule also with a dark spot on each side posteriorly; ventrally yellowish brown with a pair of large and shaded brown spots in the hypostomal areas. Antenna dark brown. Mandible and maxilla iron-brown; labial palp with the last segment darker. Legs light, without spots, pretarsal claws of metathoracic legs clearly iron-coloured.

Size – Total length (including jaws) 3.8 (newhatched larva) to approx. 6 mm; morphometrical data of the head: Tab. I.

Relevant morphological features – Black setae, of various shapes and sizes, scattered almost all over the body; the fine structure of some of them from the anterior margin of the head, with longitudinal series of short spinules, is shown in Fig. 4A. Delicate white sinuous filaments (detail in Fig. 4C) dorsally scattered almost all over the body, latero-ventrally over thorax and abdomen. Head capsule longer than broad, with maximum width at the ocular tubercles. Antenna (Fig. 4D) 11- to 15-segmented (scape stout, pedicel and apical flagellomere more or less elongate). Mandible falcate, tridentate, slender and finely sharp-

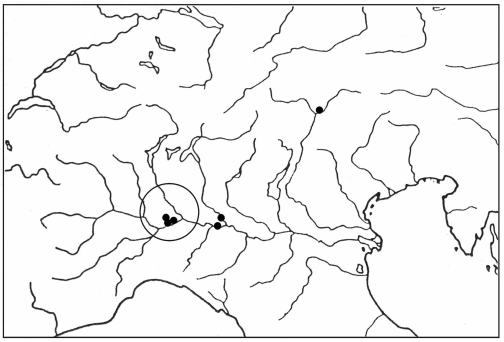

Fig. 1 – *Myrmeleon bore*, Italian distribution (bibliographic data and author's data); inside the circle: stations in the Lomellina area.

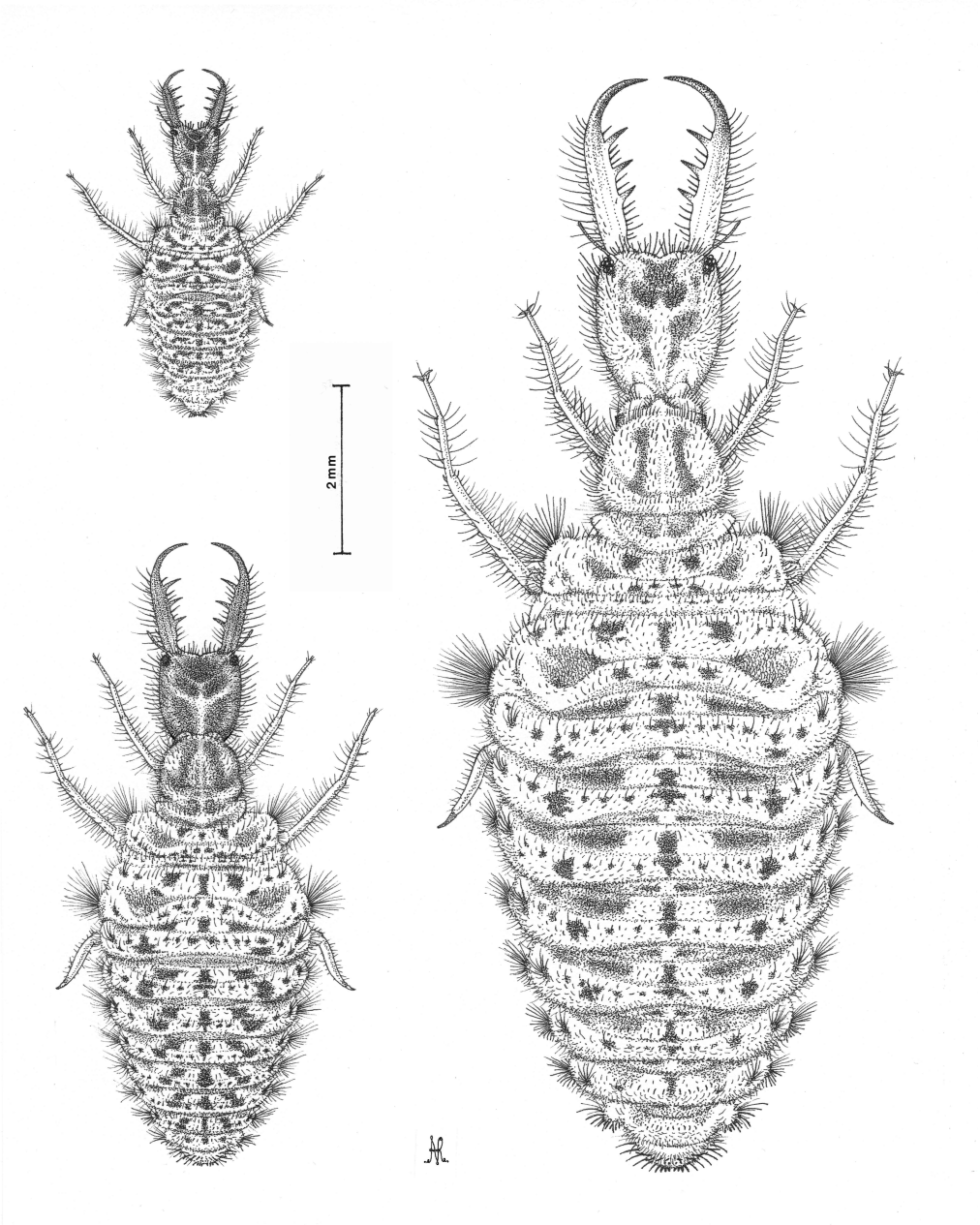

Fig. 2 – *Myrmeleon bore*: 1st, 2nd, 3rd instar larva (R. Nicoli Aldini *del.*).

ened, longer than the cephalic capsule; labium (Fig. 4E) with palps 3-segmented. Thoracic spiracle: Fig. 4F. “Digging setae” of the 9th sternite: Fig. 3C-D, Fig. 4G, Tab. II. Their most frequent pattern comprises 8 setae in the posterior row (4 on each side, forming the structure named “palette” by Steffan (1975), in which the most lateral seta is longer and sharpened), near the hind margin of the sternum; 4 setae in the row immediately in front; and 2 in front of them, in the discal area of the sternite, placed side by side or asymmetrically, more or less distant from each other. Sometimes there is only one or none of the latter.

Tab. I – *Myrmeleon bore* and *M. inconspicuus*, measurements of the head and number of antennal segments (12 specimens were measured and examined for each larval stage of each species).

	Myrmeleon bore			***Myrmeleon inconspicuus***		
Measurements (mm)	L 1	L 2	L 3	L 1	L 2	L 3
Head length (incl. jaws)	1.77-1.93	2.65-2.92	4.16-4.62	1.46-1.64	2.10-2.35	3.20-3.77
Length of the head capsule	0.84-0.92	1.28-1.45	2.06-2.26	0.68-0.81	1.05-1.17	1.62-1.90
Width of the head capsule	0.75-0.81	1.12-1.26	1.71-1.90	0.64-0.75	0.94-1.07	1.45-1.71
Number of antennal segments	11-15	8-14	9-15	11-15	13-16	10-15

Tab. II – *Myrmeleon bore*, layout patterns of "digging setae" on the 9th sternite, and their relative frequencies for each larval stage and for the whole number of larvae examined.

Layout patterns of the "digging setae"	**L 1** (69 larvae examined)	**L 2** (150 larvae examined)	**L 3** (44 larvae examined)	**L 1 + L 2 + L 3** (263 larvae examined)
2 (asymm.) – 5 – 7	-	1 (0.66%)	-	1 (0.38%)
2 (asymm.) – 3 – 8	-	1 (0.66%)	-	1 (0.38%)
0 – 4 – 8	5 (7.25%)	5 (3.35%)	-	10 (3.80%)
1 – 4 – 8	9 (13.04%)	11 (7.35%)	4 (9.09%)	24 (9.13%)
2 (asymm.) – 4 – 8	42 (60.87%)	109 (72.66%)	31 (70.46%)	182 (69.20%)
2 (symm.) – 4 – 8	11 (15.94%)	13 (8.66%)	4 (9.09%)	28 (10.65%)
3 (asymm.) – 4 – 8	-	7 (4.66%)	5 (11.36%)	12 (4.56%)
1 – 5* – 8	2 (2.90%)	3 (2.00%)	-	5 (1.90%)

* symmetric (*i. e.* in one row) or asymmetric but close to each other.

Tab. III – Morphological features discriminating *Myrmeleon bore* and *M. inconspicuus* larvae.

Species/Characteristics	***Myrmeleon bore***	***Myrmeleon inconspicuus***
SIZE	Slightly larger (see Tab. I for the head).	Smaller (see Tab. I for the head).
MANDIBLE	Relatively longer, more slender distally; in all stages, mandible a little longer than the head capsule.	Relatively shorter, less slender distally; only in L 1 mandible longer than the head capsule.
LABIAL PALP	3-segmented (see Fig. 4E).	4-segmented.
THICK CEPHALIC SETAE	With longitudinal series of short spinules (evident mainly in 1st instar larva, see Fig. 4A).	With longitudinal series of slightly longer and thinner spinules (evident mainly in 1st instar larva, see Fig. 4B).
NUMBER AND LAYOUT OF "DIGGING SETAE" ON THE 9TH STERNITE	Intermediate group forming a row of 4 setae (only exceptionally 5); anterior (discal) group comprising 0-3 setae (see Fig. 3C-F, Fig. 4G, and Tab. 2).	Intermediate group consisting of at least 6 setae (only exceptionally 5, not rarely 7, rarely 8-9) disposed in more or less regular row; anterior (discal) group comprising 0-7 setae disposed more or less irregularly (see Fig. 3G-I).

2nd instar larva (L 2) (main differences in comparison with L1)

Colouring – Dark colouring of the head capsule generally a little less wide than in L 1, with large dark spots dorsally (Fig. 2) and a dark spot on each side posteriorly; ventrally with a pair of oval dark spots.

Size – Total length (including jaws) approx. 6-8 mm; morphometrical data of the head: Tab. I.

Relevant morphological features – Maximum width of the head capsule a little behind the ocular tubercles. Antenna 8- to 14-segmented. Layout pattern of "digging setae" of the 9th sternite rather variable (Tab. II), their more frequent settings correspond to the 2 (asymmetric or symmetric) – 4 – 8 type.

3rd instar larva (L 3) (main differences in comparison with L 2)

Colouring – Head capsule dorsally with one frontoclypeal dark spot and some symmetric epicranial dark spots, less wide than in L 2 (Fig. 2); on each side with a dark spot posteriorly; ventrally with a pair of dark spots with shaded margins in the hypostomal areas. Antenna uniformly brown or yellow ochre, with the last segment darker; mandible yellow ochre, gradually darker in the points.

Size – Total length (including jaws) approx. 8.5-12.5 mm; morphometrical data of the head: Tab. I.

Relevant morphological features – Antenna 9- to 15-segmented (only 6 segments in both antennae, with various flagellomeres fused together, in an anomalous specimen). Spinosity of the ventral side of the mandible: Fig. 4H. Layout pattern of "digging setae" of the 9th abdominal sternum rather variable (Fig. 3E-F, Tab. II), their more frequent settings as in L 2.

Through the development from L1 to L3, therefore, the dark colouring of the head decreases in width; the mandible is dark in L1 and L2, lighter in L3. The head capsule modifies its shape a little and remains slightly shorter than the mandible. On the 9th sternite, the "digging setae" of the discal group tend to increase in number (in L3, not rarely 3 setae, placed asymmetrically, are to be found) (Tab. II).

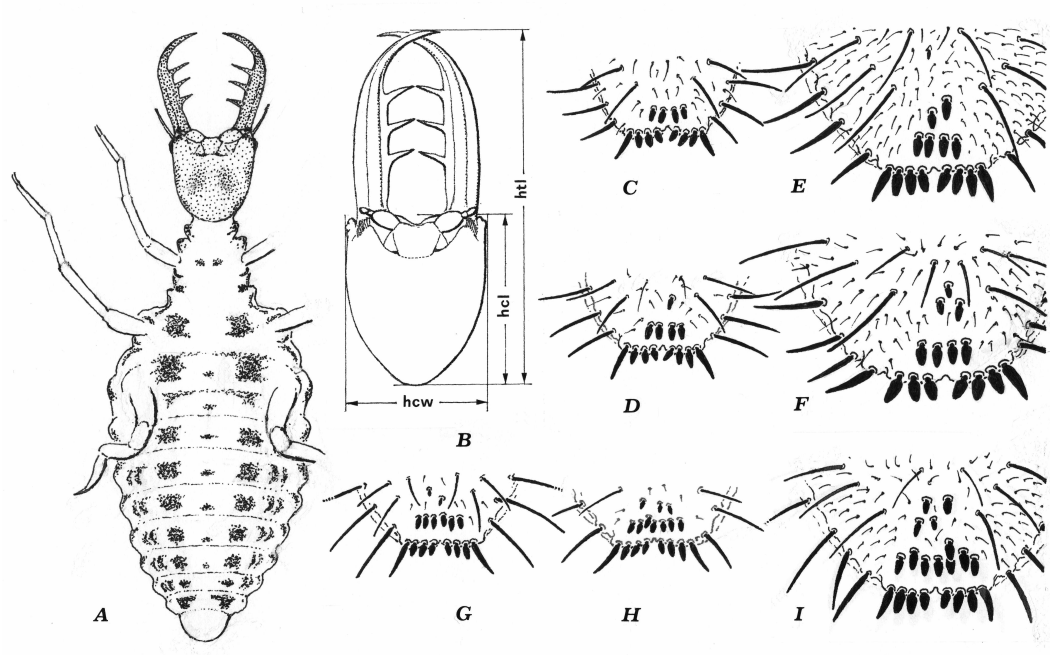

Fig. 3 – *Myrmeleon bore*: **A**, schematic distribution of ventral spots in 1st instar larva; **B**, technique of measurement of larval head (htl = total length of the head; hcl = length of the head capsule; hcw = width of the head capsule); **C**-**F**, some layout patterns of "digging setae" of 9th sternite in 1st (C: 0-4-8; D: 1-4-8) and 3rd (E: 2-4-8; F: 3-4-(7)8) instar larva. *M. inconspicuus*: **G**-**I**, idem in 1st (G: 2-6-8; H: 3-7-8) and 3rd (I: 4-8-8) instar larva. (Various magnification; R. Nicoli Aldini *del.*).

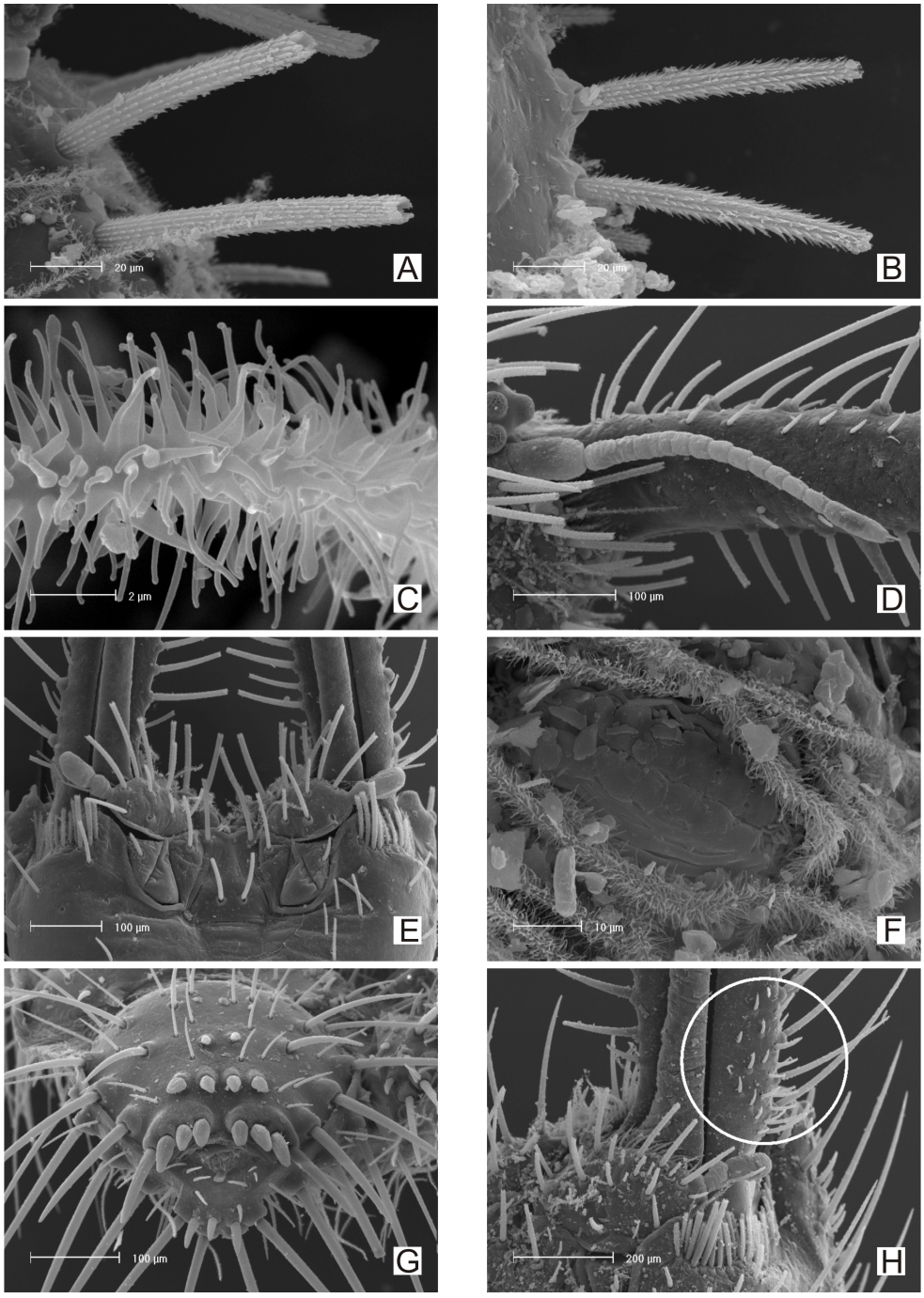

Fig. 4 – **A**, *Myrmeleon bore*, L 1: detail of two setae on the anterior margin of the frontoclypeal region; **B**, ditto of *Myrmeleon inconspicuus*, L 1; **C**, *M. bore*, L 1 (cast skin): detail of a delicate sinuous filament from the thoracic perispiracular region, at high magnification; **D**, *M. bore*, L 1: antenna. **E**, *M. bore*, L 1: labium; **F**, *M. bore*, L 1 (cast skin): thoracic spiracle; **G**, *M. bore*, L 1: 9th abdominal sternite; **H**, *M. bore*, L 3: ventral detail of mouth-parts (inside the circle: spinosity of the ventral side of the mandible). (SEM photos).

Tab. IV – *Myrmeleon bore*, number and percentages of the three larval stages in three subsequent samplings made in the span of twelve months in the same poplar grove with sandy soil, at Pieve Albignola near Terdoppio stream (Province of Pavia), years 1983-1984.

Larval stage	1.X.1983 (89 larvae)	1.VII.1984 (25 larvae)	28.IX.1984 (61 larvae)
L 1	23 (25.8%)	0 (0.0%)	31 (50.8%)
L 2	62 (69.7%)	2 (8.0%)	30 (49.2%)
L 3	4 (4.5%)	23 (92.0%)	0 (0.0%)

Almost all over the body, black setae of various shapes and sizes, as well as delicate white sinuous filaments, increase in number.

Some morphological characteristics discriminating between *M. bore* and *M. inconspicuus* larvae are summarized in Tab. I (head measurements) and Tab. III.

Bio-ecological notes, life cycle duration

Only a short account can be reported here. In the southern Lomellina area, *M. bore* occurs in various localities, in environments with suitable sandy soil: the banks of the Po river bed, the poplar groves near this major river and its tributaries, and the sandy banks (the typical “dossi” of the Lomellina area, with the surviving small oak-woods (*Quercus pedunculata*), associated with the invasive robinia (*Robinia pseudacacia*) and a few other species of trees) in the inland agricultural plain. In all these environments, this antlion is syntopic with *M. inconspicuus*, which is generally more abundant, only rarely the larvae of these two species were found in similar percentages. The pits of *M. bore* are located in the same places as those of *M. inconspicuus*, in bare soil or, especially for the pits of the 1st and 2nd instar larvae, which are closer together, near the base of herbs and small shrubs, in any case in sunny places. Syntopy with *Myrmeleon formicarius* Linné, 1767 and *Euroleon nostras* (Geoffroy in Fourcroy, 1785) (both, but especially the latter, scarcer than the other two species) was observed in some environments such as sandy banks in the inland plain, near small oak woods (Nicoli Aldini, 1983), and on a sandy slope far from rivers. These four species display partially different preferences in the location of their pits. The pits of *E. nostras*, for instance, are always found under overhangs – as has been well known for many years, see *e.g.* Steffan (1975), Yasseri & Parzefall (1996). It is likely that *M. bore* larvae, as well as those of *M. inconspicuus* (Steffan, *l.c.*), are able to survive the prolonged submersions of the sand banks of the Po river bed, which occur in some periods of the year.

Field samplings and laboratory rearings in climatic conditions similar to those of the natural habitat indicate that the life cycle of *M. bore* in the Po valley may be completed for the majority of the individuals in one year, compared with 2-3 years in central Europe (Hölzel, 1973; Gepp & Hölzel, 1996; Hölzel & Wieser, 1999). This fact in the Lomellina area is demonstrated by the high number of 3rd instar larvae of *M. bore* in July and their low number or absence in September-October, as well as by the very low number of 1st and 2nd instar larvae in July and their abundance in September-October (Tab. IV). Only a small number of larvae takes two years (personal observations), as has also been found for *M. inconspicuus* (Principi, 1943; Steffan, 1975; Pantaleoni, 1982; Nicoli Aldini, unpublished data). In the laboratory rearings, *M. bore* adults started to emerge in the first ten days of June, ending in the second ten days of August. During field research in the Lomellina area, in June-July adults of this species were never found (maybe

they emerge later or are scarcer), whereas some specimens of *M. inconspicuus* were captured in July on herbaceous plants.

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